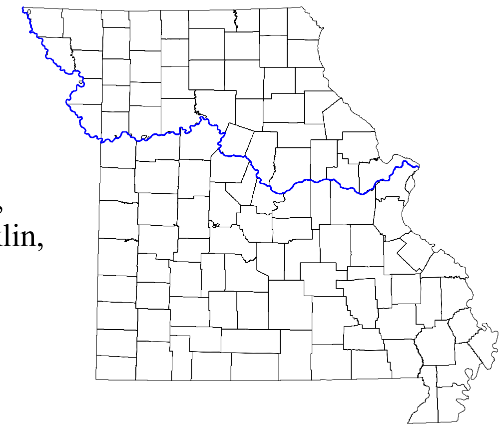
Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Loads (TMDLs)
for
Chlordane and Polychlorinated Biphenyls
in the
Missouri River

Completed: October 5, 2006
Approved: November 3, 2006

Total Maximum Daily Loads (TMDLs)
For the Missouri River
Pollutants: Chlordane and Polychlorinated Biphenyls (PCBs) in Fish Tissue



Name: Missouri River

Location: Across 25 counties: Atchison, Holt, Andrew, Buchanan, Platte, Clay, Jackson, Ray, Lafayette, Carroll, Saline, Chariton, Howard, Cooper, Moniteau, Boone, Cole, Callaway, Osage, Montgomery, Gasconade, Warren, Franklin, St. Charles and St. Louis

Hydrologic Unit Codes (HUC): 10240001, 10240005, 10240011, 10300101, 10300102, 10300200

Water Body Identification Numbers (WBID): (from the mouth at St. Louis to the Iowa border)1604 (100 miles), 701 (129 miles), 356 (125 miles) and 226 (179 miles)

Missouri Steam Classification: The Missouri River is classified in the Missouri Water Quality Standards (WQS) as a Class P[1] stream

Beneficial Uses for Missouri River[2]:
• Livestock and Wildlife Watering
• Protection of Aquatic Life and Human Health – Fish Consumption
• Whole Body Contact Recreation, Category B
• Secondary Contact Recreation
• Irrigation
• Drinking Water Supply
• Industrial

Pollutant: Chlordane and PCBs in fish tissue

Size of Impaired Segment: 533 miles

Pollutant Source: Many point and nonpoint sources

TMDL Priority Ranking: High

[1] Class P streams maintain permanent flow even in drought periods
[2] For beneficial uses see 10 CSR 20-7.0310(C) and Table (H)

1. Introduction

1.1 Study Area Description:

The Missouri River is 2,565 mile long starting at its headwaters in the Jefferson, Madison and Gallatin Rivers, which converge near Three Forks, Montana, to form the Missouri River. The river flows north through mountainous canyons before emerging from the mountains near Great Falls, Montana. It flows east across the plains of Montana into North Dakota, then turns southeast flowing into South Dakota and along the north and eastern edge of Nebraska. The river forms part of Nebraska's border with South Dakota and nearly its entire boundary with Iowa, flowing past Sioux City and Omaha. The river forms the entire boundary between Nebraska and Missouri and part of the boundary between Missouri and Kansas. At Kansas City, the river turns eastward and flows across Missouri where it joins the Mississippi River just north of St. Louis. The Missouri River sub-basin is the largest sub-basin in the Mississippi River basin, covering more than 500,000 square miles.

The TMDL discussed in this report is for the portion of the Missouri River that begins on the border of Iowa and Missouri, approximately 10 miles north of Watson, Missouri, at River Mile 552 (Figure 1). Table A in the appendix provides a detailed description of the 25 sampling locations along the Missouri River shown in Figure 1. Land use for this 533-mile portion[3] of the Missouri River is shown in Figure 2. Within the impaired segments, three major tributaries enter the Missouri River. These tributaries are the Platte, Blue and Osage Rivers, and their confluences are at Missouri River Miles 391, 358 and 133, respectively. Table 1 summarizes the information on the impaired segments in the Missouri River based on the 2002 303(d) listing.

Table 1: Missouri 2002 303(d) List for Impaired Segments in Missouri River

WBID	Waterbody	Size	Unit	Pollutant	Downstream County	Upstream County	Priority
1604	Missouri River	100	Miles	Chlordane, PCBs	St. Louis	Gasconade	High
701	Missouri River	129	Miles	Chlordane, PCBs	Gasconade	Chariton	High
356	Missouri River	125	Miles	Chlordane, PCBs	Chariton	Jackson	High
226	Missouri River	179	Miles	Chlordane, PCBs	Jackson	Atchison	High

[3] There is a 19-mile discrepancy between the length of the river (from the Iowa state line to the Mississippi) as recorded in the WQS vs. the mile marker on the river itself at the Iowa line. This amounts to a 3.4 percent difference, which is well within the acceptable standard deviation. However, as ArcView becomes more accurate, the river will be re-measured and in due time this will be reflected in the WQS.

Figure 1: Location Map for Impaired Segments in Missouri River

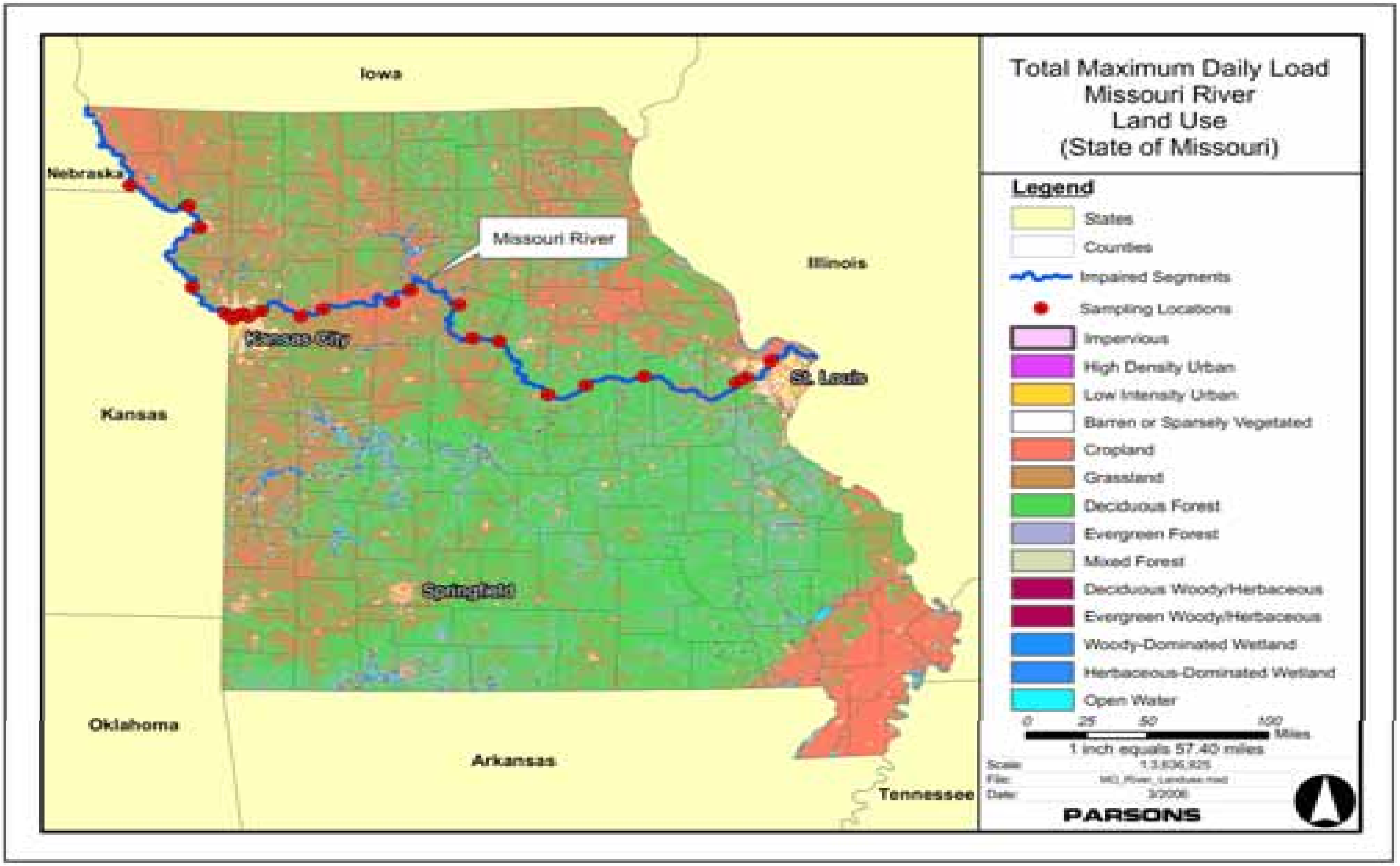


Figure 2: Land Use for Missouri River Watershed within State of Missouri

1.2 Fish Advisories in Missouri:
The Missouri Department of Conservation (MDC) has monitored levels of toxic contaminants in fish from Missouri lakes and rivers since 1984. At that time, MDC discovered elevated levels of chlordane in fish in the Missouri, Mississippi and Meramec rivers. MDC, the U.S. Environmental Protection Agency (EPA) and the department all provide fish tissue sample results to the Missouri Department of Health and Senior Services (DHSS) for use in determining health risks to fish consumers. DHSS, in turn, issues fish consumption advisories. DHSS has issued advisories based on pesticide contaminants in fish since 1985. Past DHSS fish advisories instructed anglers to limit consumption of fatty fish (carp, catfish, buffalo, drum, suckers and paddlefish) to one meal per week. This advisory was rescinded in 2001. Trout also have a high level of fat, but are considered safe to eat from anywhere in the state. In 2002, sturgeon eggs were added to the only existing PCB advisory, which has been in place for sturgeon meat from the Missouri River since 1997.

DHSS issues its fish advisory every year around March or April. The advisory is made available to the public through press releases and may be accessed by calling DHSS at 1-866-628-9891. These advisories are also distributed to all Missouri county health departments and are posted on the Internet. The 2006 advisory may be found at www.dhss.mo.gov/NewsAndPublicNotices/06FishAdvisory.pdf.

2. Description of the Applicable Water Quality Standards

2.1 Beneficial or Designated Uses:
These uses are listed on page one. The use that is impaired is protection of warm water aquatic life and human health associated with fish consumption.

2.2 Anti-degradation Policy:
Missouri's WQS include EPA's "three-tiered" approach to anti-degradation and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after Nov. 29, 1975, the date of EPA's first WQS regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an anti-degradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and water of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

2.3 Specific Criteria:

2.3.1 Chlordane

The specific criteria for chlordane are found in Missouri's Water Quality Standards, 10 CSR 20-7.031, Table A, under Persistent, Bioaccumulative, Man-made Toxics. The limit for chlordane *in water* related to human health protection associated with fish consumption is 0.00048 micrograms per liter (µg/L or parts per billion). However, elevated chlordane levels in water are not the problem. As chlordane tends to bioaccumulate in fish, this TMDL will be based on fish tissue chlordane levels. Fish tissue levels refer to the amount of chlordane in the fillet, or edible portion, of fish. The U.S. Food and Drug Administration (FDA) developed a fish tissue action level of 0.3 milligrams per kilogram (mg/kg or parts per million) for technical grade chlordane. Note: 1 kilogram equals approximately 2.2 pounds. However, the department and DHSS use the action level of 0.1 mg/kg sum-of-the-isomers of chlordane.[4] If the level of a toxic contaminant exceeds this action level or the unrestricted consumption level, a fish consumption limit advisory that provides a risk-based, safe consumption level for target populations is issued regarding the potential health risk associated with long-term consumption of contaminated fish.

2.3.2 PCBs

The specific criteria for PCBs are found in Missouri's WQS, 10 CSR 20-7.031, Table A, under Persistent, Bioaccumulative, Man-made Toxics. The limit for PCBs *in water* related to human health protection associated with fish consumption is 0.000045 µg/L. The FDA set a 2.0 mg/kg limit on PCBs in fish tissue for interstate shipment of fish for human consumption. DHSS currently uses this number to issue fish advisories related to PCBs and the department uses the same number to judge impairment of Missouri water bodies by PCBs. However, DHSS has a revised fish advisory methodology that follows EPA guidance, so the threshold value for PCBs will change. The new threshold value for unrestricted consumption is expected to be 0.04 mg/kg of total PCBs in fish tissue. Following adoption of these new guidelines by DHSS, the next state 303(d) listing methodology document will acknowledge them and may be revised accordingly.

[4] Data can be collected as technical chlordane or sum-of-the-isomers of chlordane, in which case the action level is 0.1 mg/kg. Sum-of-the-isomers of chlordane is usually comparable to FDA's action level of 0.3 mg/kg technical grade chlordane when the contamination is recent, because there is a lot of the technical chlordane still present. However, after a few years the comparison no longer works well. The department, MDC, EPA and DHSS quantify chlordane by summing the following four chlordane isomers: cis-chlordane, trans-chlordane, cis-nonachlor and trans-nonachlor.

3. Current Water Quality Condition and Desired Endpoint

3.1 Current Water Quality Condition:

Several agencies collected fish tissue samples at numerous monitoring sites along the Missouri River from 1976 to 2004. The goal of the fish tissue monitoring and survey program was to analyze fish tissue samples for chlordane and PCBs in order to define water body segments impacted by contamination. Bottom feeding fish such as carp were sampled because of their feeding or dwelling preferences near the bottom of the water column where chlordane and PCBs remain in the sediments.

Even though they have been banned, both chlordane and PCBs degrade very slowly, making them particularly persistent in the environment. They remain in the soil for long periods of time. Because these pollutants are not soluble they are not readily found in the water column. Instead they adsorb to soil particles in lakebed or streambed sediments. Bottom-feeding fish, such as carp, become exposed to chlordane and PCBs due to their feeding and dwelling preferences near streambeds or lakebeds where contaminated sediments persist. Fish uptake these pollutants in water through their gills and through the consumption of contaminated aquatic organisms. Once the pollutants are absorbed into the bloodstream, they accumulate primarily in fatty tissues. Once in the fatty tissues, the pollutants have the ability to biomagnify, or increase in concentration, as the compound is transferred through the food chain. These fish include fatty fish, such as carp, catfish, buffalo, drum, suckers and paddlefish.

3.2 TMDL Endpoint:

The department uses threshold levels of 0.1 mg/kg of chlordane (sum of isomers) and 2.0 mg/kg of total PCBs in fish tissue to determine support of the designated use. As just stated, because DHSS has a revised fish advisory methodology that follows EPA guidance, the threshold value for PCBs will change. The new threshold value for unrestricted consumption will be 0.04 mg/kg of total PCBs in fish tissue. If the average levels of these compounds exceed these levels in fillets of the fish sampled, the water body is considered to be not supporting the fish consumption use. These will be used for the endpoints for these TMDLs and the achievement of these targets should lead to the removal of fish consumption advisories. Missouri's protocol for removing or down grading an advisory requires at least two years of data below these targets.

4. Source Inventory and Assessment

4.1 Chlordane:

Chlordane has been identified as a pollutant of concern because it is a bio-accumulative pesticide that is carcinogenic and can cause both acute and chronic toxic effects. Its polycyclic chlorinated organic structure produces deleterious biological effects similar to those of DDT, PCBs and other related substances (MDE, 2000).

Chlordane is a manufactured chemical that was used as a pesticide in the U.S. from 1948 to 1988 (ATSDR, 1995). Since its introduction in the 1940s, chlordane was used as a broad-spectrum pesticide for agricultural, home and commercial control of insects until it was withdrawn from the

market in 1988. The original source of chlordane was runoff, particularly from urban areas where widespread termite eradication occurred around homes in the 1970s and 1980s. Chlordane was also used at nurseries, on golf courses and in agriculture. Chlordane was banned for agricultural use in 1975 and for all uses in 1988; therefore, no additional loading should occur. Some of its trade names include Oktachlor and Velsicol 1068 (ATSDR, 1995). At the height of production, chlordane was the second most widely used organochlorine insecticide in the U.S., with annual production of about 11 million kg/year. Production in the U.S. in 1974 amounted to 9.5 million kg (IPCS, 1988). Over 70,000 tons of chlordane has been manufactured since 1946 (U.S. EPA, 1998).

As previously mentioned, chlordane degrades very slowly, and thus is extremely persistent in the environment (with the ability to stay in the soil for over 20 years). It bio-accumulates in the tissue of bottom-feeding fish (such as carp) which become exposed to chlordane due to their feeding or dwelling preferences near chlordane-contaminated sediments. Eating fish contaminated by chlordane will not make a person immediately ill. However, over a long period of time, chlordane may damage the nervous system, digestive system and the liver (MDNR, 2001).

The department recognizes that there is still chlordane in products in storage sheds, barns and basements. It is possible that chlordane could still find its way into the environment through leaks, use of the product or improper disposal. However, it is estimated that the amount that might actually reach the river is negligible.[5] The reasons for this are: 1) since it has been banned since 1988, the number of people who still have a product containing chlordane is small, 2) chlordane would be only a small portion of the ingredients in the product, 3) The number of people who would use the product is smaller yet and 4) if applied according to directions, it should not cause a problem. Overall, there is no reason to expect that the levels of chlordane in the environment, and therefore chlordane levels in fish tissue, will do anything but decline in the future.

4.2 Polychlorinated Biphenyls (PCBs):

PCBs are a mixture of up to 200 different chlorinated compounds and are stable under conditions of high pressure and high temperature. PCBs are manmade compounds that have been used commercially since 1929. These chemicals were manufactured as combinations of chlorinated biphenyls that differed according to the percentage of chlorine in the mixture. PCBs had a wide variety of industrial applications due to their chemical stability and flame resistance. However, these characteristics also enabled them to remain highly persistent in the environment. PCBs were commonly used as plasticizers, heat-transfer fluids, solvent extenders, hydraulic fluids, flame retardants, sealers, ink carriers, organic diluents and dielectric fluids. They are found in transformers, capacitors, florescent lighting fixtures, televisions, computers, microscope oil, hydraulic oil, caulking compounds and elastic sealant made from 1966 to 1975. The manufacturing of PCBs stopped in the United States in 1977 due to concerns about the persistence of PCBs in the environment and evidence that they bioaccumulate, which can cause harmful health effects.

U.S. industry purchased approximately 1.25 billion pounds of PCBs by the time production stopped in 1977 (U.S. EPA, 1993). EPA estimates that 60 percent, or 750 million pounds, of PCBs produced are still in use in the U.S. in approximately 150,000 PCB transformers and 2.5 million mineral oil transformers (Graham, 1987). Another 36 percent (450 million pounds) of PCBs were

[5] Personnel correspondence with Paul Andre, Missouri Department of Agriculture, Pesticide Program, 7/06.

either placed in landfills or dumps or were available to biota via air, water, soil and sediments. The remaining four percent (55 million pounds) were destroyed by incineration or were degraded in the environment (U.S. EPA, 1993). Monsanto Chemical Company in Sauget, Illinois, produced approximately 99 percent of commercial PCBs for U.S. industry and sold the compounds under the trade name Aroclor (ATSDR, 1995a). A four digit numbering code identifies the Aroclors. The first two digits denote the number of carbon atoms in the biphenyl group and the last two digits represent the approximate percentage of chlorine in the mixture. The most common PCBs manufactured include Aroclor 1242, Aroclor 1248, Aroclor 1254 and Aroclor 1260 (Cairns et. al., 1986).

The behavior of PCBs differs depending on the number of chlorine atoms present. Generally, these compounds are relatively insoluble and have the ability to absorb strongly into organic matter. As the chlorine content increases, the solubility of the compounds decrease and the mixture becomes more viscous. PCBs are highly lipophilic (fat loving) and bio-accumulate in fish tissue, which can result in very high concentrations that are unsafe for human consumption (U.S. EPA, 1980). Currently, the primary source of PCB ingestion is through the consumption of contaminated fish (USDHHS, 1995). Fish uptake of PCBs in water through their gills and through the consumption of contaminated aquatic organisms. As with chlordane, PCBs are absorbed into the bloodstream and accumulate primarily in fatty tissues. In these fatty tissues, they have the ability to biomagnify or increase in concentration, as the compound is transferred through the food chain. In humans and other mammals, PCBs accumulate in the gastrointestinal tract, adipose (fatty) tissue and skin.

As already stated, U.S. production of PCBs ended in 1977 because of the evidence that they accumulate in the environment, which can cause harmful health effects. Although production of PCBs was banned, note that the ban was on the manufacture, processing, and distribution in commerce of PCBs. The ban did not extend to existing products containing PCBs, such as transformers. Poorly maintained hazardous waste sites that contain PCBs, industrial and municipal incinerators burning organic waste, illegal or improper dumping of PCB wastes (such as transformer fluids and some capacitors) and leaks from electrical transformers continue to release PCBs into the environment. However, since PCBs are no longer produced, a downward trend in the environment is inevitable.

5. Determination of TMDL and Allocation[6]

The following equation was used to calculate the TMDL.

TMDL = WLA + LA + MOS (Eq. 1)

where:

TMDL: Total Maximum Daily Load
WLA: Waste Load Allocation (for point sources)
LA: Load Allocation (for non-point sources)
MOS: Margin of Safety (to account for uncertainties)

[6] Calculations and graphs by Parsons Corporation, a Pasadena-based engineering and construction firm

5.1 TMDL/Loading Capacity:
TMDL or loading capacity is defined as the maximum pollutant load that a water body can assimilate and still attain WQS. EPA banned the use of chlordane in 1988. While the department recognizes that there is still chlordane in existence that is unaccounted for, with the potential to enter the river system, the amount that might actually reach the river is believed to be negligible (see section 4.1). Again, there is no reason to expect that the levels of chlordane in the environment and in fish tissue will do anything but decline in the future. Therefore, the TMDL for chlordane in the 533 mile impaired segment along the Missouri River is set as zero pounds/day.

Similarly, EPA banned the use of PCBs in 1977. Again, the department acknowledges that there is the potential for a certain amount of PCBs to leak into the environment (see Source Inventory-PCBs above). However, judging from the available data, that amount is deemed to be small and declining. Therefore, the TMDL for PCBs in the 533 mile impaired segment along the Missouri River is set as zero pounds/day.

5.2 Waste Load Allocation:
As stated earlier, these two compounds are mainly a sediment issue and amounts in the water column are virtually non-detectable. There are no Missouri facilities which discharge either directly to the Missouri River or to a tributary where the Missouri River is the first classified water body, that have that potential for discharging detectable amounts of PCBs or chlordane. Since chlordane and PCBs were banned in 1988 and 1977, respectively, there should be negligible discharge of chlordane and PCBs into streams from wastewater treatment plants and other point sources. Therefore, the WLA is set as zero pounds/day in this TMDL.

5.3 Load Allocation:
Since chlordane and PCBs were banned, there will be only minor and/or infrequent application of chlordane anywhere that might be discharged under runoff conditions and enter the river. As time passes, this, too, will decline. Therefore, the LA is set as zero pounds/day in this TMDL.

5.4 Margin of Safety:
In order to ensure there is no threat of chlordane and PCB levels impairing fish consumption, fish advisories will remain in effect until all samples taken from fish have met the desired endpoint for two years. The department will coordinate with DHSS in guarding against threats to human health associated with fish consumption from these two contaminants.

5.5 Seasonal Variation:
There is no seasonal variation associated with this TMDL.

6. Implementation

Since chlordane and PCBs have been banned, there is no specific remediation plan for this impairment. In regard to existing stores, stashes and unused inventory of these products, Missouri continues to collect them as they are turned in for proper disposal through various hazardous waste and hazardous household waste disposal initiatives. A major source of PCBs is transformers. Transformer fluid is tested and properly disposed of as the transformer ends its useful life.

Otherwise, fish tissue concentrations are declining as chlordane and PCBs are purged or degraded in water body sediments over time. Figures 3 and 4 show the average annual chlordane and PCB concentrations and their corresponding moving average trends.

Figure 3: Average Annual Chlordane Concentration (as Sum-of-the-Isomers) and Three-Year Moving Average in Missouri River over Time

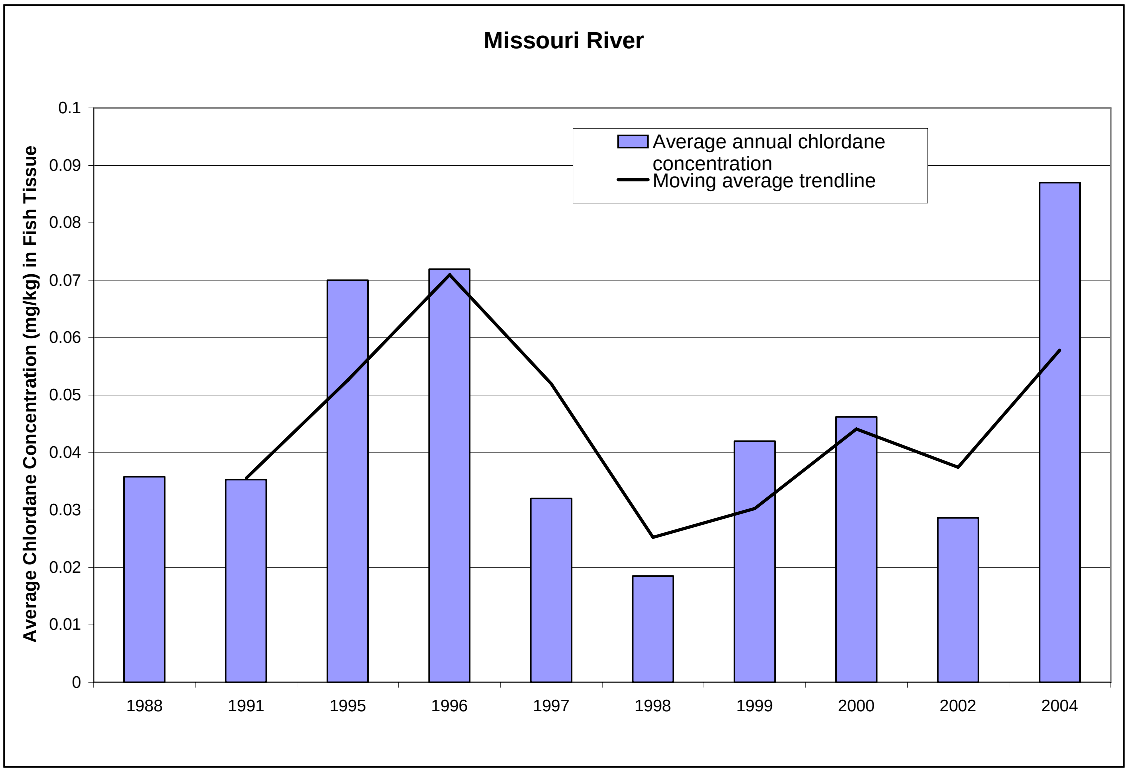
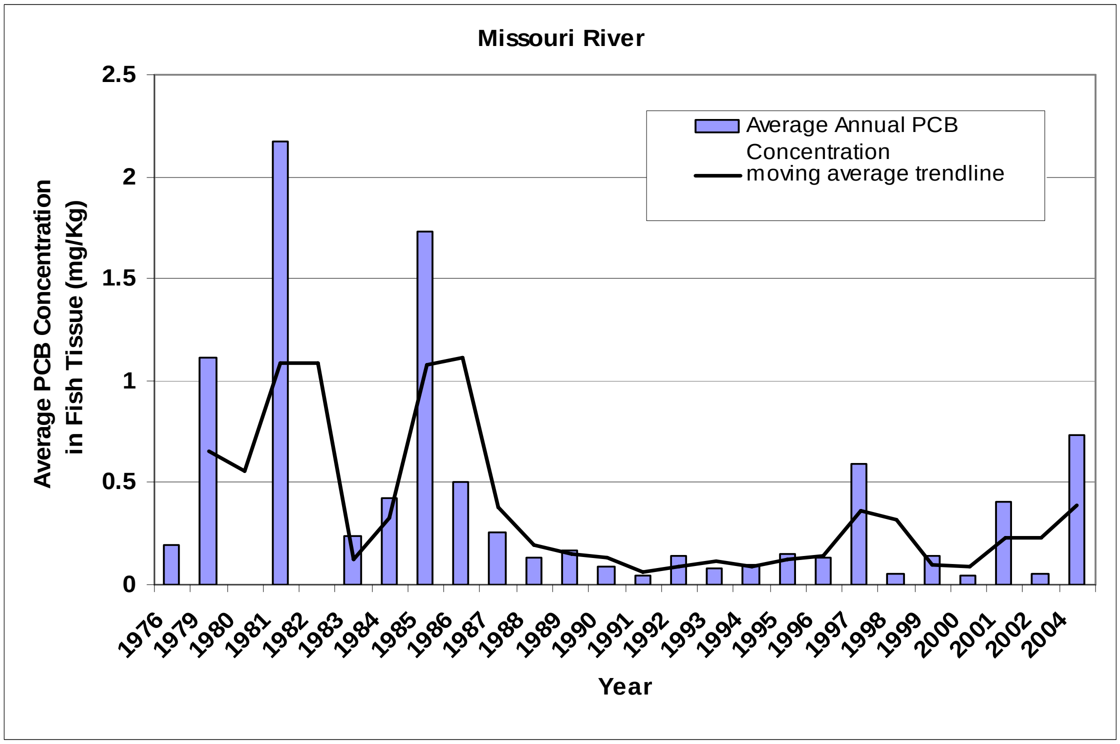


Figure 4: Average Annual PCB Concentration and Three-Year Moving Average in Missouri River over Time



The department recognizes that data collected to date do not always reflect a downward trend of PCBs or chlordane on a year-to-year basis; however, that this is most likely due to collection inconsistencies. Some years of data contain tissue samples of many different fish species, but some years contain only one or two species of fish. Fatty fish, such as carp, tend to absorb more PCBs than a less fatty fish such as catfish. Likewise, feeding habits, rainfall and age and size of the fish can effect the amount of sediment (thus PCBs and chlordane) assimilated by fish or the bio-accumulative effect. The most recent data predominately sampled catfish and sturgeon, however in 2004, only sturgeon was sampled. This would tend to show increasing levels of PCBs and chlordane in later years and obscure the overall downward trend. When only fillets are considered, from the year 2000 to the present, concentrations of both compounds are consistently below the stated action levels.

As mentioned, these pollutants degrade slowly and are extremely persistent in the environment. However, since they are no longer produced, a downward trend is inevitable and this TMDL recommends development of a consistent protocol for measurement of the pollutants in fish tissue and continued sampling.

This is a phased TMDL, which means that if future data indicates fish tissue chlordane and PCB levels are not continuing to decline, this TMDL will be re-evaluated. This TMDL will be incorporated into Missouri's Water Quality Management Plan.

7. Public Participation

This TMDL was on public notice from June 9 to July 9, 2006. Due to comments received during the first notice period, which resulted in substantial changes to the TMDL document, a second public notice period was needed. This period was from Aug. 30 to Sept. 29, 2006. Groups who received the public notice announcement included the Missouri Clean Water Commission, the Water Quality Coordinating Committee, the water quality departments in neighboring states where the Missouri River is a shared border (Kansas and Nebraska), the 155 Stream Team volunteers in the watershed, and the 51 legislators representing all the counties bordering this river. Also, the department posted the notice, the Missouri River Information Sheet and this document on its Web site, making them available to anyone with access to the Web. The department has placed a copy of the notice, the comments received and its responses in the Missouri River file.

8. References

Agency for Toxic Substances and Disease Registry (ATSDR) (1995). ToxFAQs for Chlordane, http://www.atsdr.cdc.gov/tfacts31.html

Agency for Toxic Substances and Disease Registry (1995a). Toxicological Profile for Polychlorinated Biphenyls, http://www.atsdr.cdc.gov/toxprofiles/tp17.html

Cairns, T. et al. (1986). Analytical Chemistry of PCBs, PCBs and the Environment Volume I., Waid, J. S. (Ed.), CRC Press, Boca Raton, p.2-45

Graham, F. J. (1987). Eliminating PCBs, *American City and County* 102: 134-137

International Programmer on Chemical Safety (IPCS) (1988). Health and Safety Guide No. 13 – Chlordane, http://www.inchem.org/documents/hsg/hsg/hsg013.htm

Iowa Department of Natural Resources (DNR) (2001). Chlordane TMDL for Cedar Lake (Linn County, Iowa), http://www.iowadnr.com/water/tmdlwqa/tmdl/pdf/final/fcedar.pdf

Maryland Department of Environment (MDE) (2000). Total Maximum Daily Load (TMDL) Documentation for Chlordane in Baltimore Harbor, http://www.mde.state.md.us/assets/document/tmdl/baltharbor/bhchlor_tmdl_main_fin.pdf

Missouri Department of Natural Resources (MDNR) (2001). Chlordane TMDL for Creve Coeur Lake, http://www.epa.gov/Region7/water/pdf/CreveCoeurFinalTMDL.pdf

Missouri Department of Natural Resources (MDNR) (2001a). Chlordane TMDL for Lake St. Louis, http://www.dnr.mo.gov/env/wpp/tmdl/lake_stlouis_final_tmdl.pdf

Missouri Department of Natural Resources (MDNR) (2002). State 303(d) List and 305(b) Report, http://www.dnr.mo.gov/env/wpp/waterquality/303d/index.html

Missouri Department of Natural Resources (MDNR) (2005). TMDL Information Sheet – Missouri River (Chlordane and PCBs), http://dnr.mo.gov/env/wpp/tmdl/info/missouri-r-chlor-pcb-info.pdf

Kansas Department of Health and Environment (KDHE) (2000). Kansas-Lower Republican Basin Total Maximum Daily Load (Chlordane for Lower Kansas River), http://www.kdheks.gov/tmdl/klr/LowKSRvCHLORD.pdf

Parsons Corporation, a Pasadena-based engineering and construction firm

Rostad, C. E., Bishop, L. M., Ellis, G. S., Leiker, T. J., Monsterleet, S. G., and Pereira, W. E. (1995). Contaminants in the Mississippi River - Polychlorinated Biphenyls and other Synthetic Organic Contaminants Associated with Sediments and Fish in the Mississippi River, U.S. Geological Survey Circular 1133, http://pubs.usgs.gov/circ/circ1133/polychlorinated.html

USEPA (1980). Ambient Water Quality Criteria for Polychlorinated Biphenyls. EPA Report 440-580068

USEPA (1991). Technical Support Document For Water Quality-based Toxics Control, EPA/505/2-90-001, http://www.epa.gov/npdes/pubs/owm0264.pdf

USEPA (1993). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume I: Fish Sampling and Analysis. http://www.epa.gov/ost/fish/guidance.html

USEPA (1998). Great Lakes Pesticide Report, http://www.epa.gov/glnpo/bnsdocs/98summ/pest1.pdf

USEPA (1999). Draft Guidance for Water Quality-based Decisions: The TMDL Process (Second Edition), EPA Report 841-D-99-001

USEPA (2000). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume I: Fish Sampling and Analysis. EPA-823-B-00-007. November 2000. http://www.epa.gov/ost/fish/guidance.html

USEPA (2004). Current National Recommended Water Quality Criteria, http://www.epa.gov/waterscience/criteria/wqcriteria.html and http://www.oregon.gov/DHS/ph/envtox/pcbs.shtml (PCBs in Fish)

Appendix

Table A: Sampling Locations along Missouri River

Table B: Missouri River Fish Tissue Data

Table A: Sampling Locations along Missouri River

Number	Location	Station Name	River Mile	Latitude	Longitude	Data Source
1	Missouri River	Rulo, Nebraska	RM 498	40.0394	-95.4144	NDEQ
2	Missouri River	below Nodaway River, Missouri	RM 462.6	39.9003	-94.96022	MDC
3	Missouri River	Nodaway Island Access, Missouri	RM 462.1	39.9013	-94.9531	MDC
4	Missouri River	St. Joseph, Missouri	RM 448.2	39.754	-94.858	EPA/MDNR USEPA MDC
5	Missouri River	Leavenworth, Kansas	RM 397	39.3291	-94.9085	USEPA MDC USGS
6	Missouri River	Kansas City, Missouri	RM 365.8	39.1194	-94.534	EPA/MDNR USEPA MDC USGS
7	Missouri River	below I-635, Missouri	RM 374	39.1531	-94.6495	USEPA MDC
8	Missouri River	below US 169, Missouri	RM 365.9	39.113	-94.586	USEPA
9	Missouri River	above Hwy 269, Missouri	RM 363	39.1387	-94.5424	USEPA
10	Missouri River	above I-435, Missouri	RM 361	39.1515	-94.5117	USEPA
11	Missouri River	below Blue Ridge Blvd., Missouri	RM 358	39.1291	-94.4686	USEPA EPA/MDNR MDC
12	Missouri River	near Shoal Creek, Missouri	RM 351.8	39.168	-94.3723	USEPA MDC
13	Missouri River	Napolean, Missouri	RM 329.2	39.1342	-94.0645	MDC
14	Missouri River	Lexington, Missouri	RM 317.3	39.1869	-93.8965	EPA/MDNR USEPA MDC
15	Missouri River	near Malta Bend, Missouri	RM 275.3	39.2382	-93.3614	MDC
16	Missouri River	Miami, Missouri	RM 262.7	39.3289	-93.2252	MDC
17	Missouri River	Glasgow, Missouri	RM 226.5	39.2223	-92.8505	MDC
19	Missouri River	Boonville, Missouri	RM 196.7	38.9812	-92.7456	MDC

Table A: Sampling Locations along Missouri River

Number	Location	Station Name	River Mile	Latitude	Longitude	Data Source
19	Missouri	near Columbia,	RM 185	38.9597	-92.545	EPA/MDNR
20	Missouri River	Jefferson City, Missouri	RM 143.2	38.5875	-92.1788	USEPA MDC
21	Missouri River	Mokane, Missouri	RM 123.4	38.6519	-91.8831	MDC
22	Missouri River	Hermann, Missouri	RM 97.9	38.71	-91.4391022	EPA/MDNR MDC USGS
23	Missouri River	Weldon Springs CA, Missouri	RM 44.1	38.6565	-90.7332	MDC
24	Missouri River	Chesterfield, Missouri	RM 39	38.6874	-90.6627	USPHS MDC
25	Missouri River	St. Charles, Missouri	RM 28.2	38.7984	-90.4662	MDC

Table B: Missouri River Fish Tissue Data for Sum of the Isomers (SOI) of Chlordane and PCBs from 1976 to 2004

Note: For use in calculations, the original data were adjusted as follows: Where the data were recorded as "less than" values, half that value is used. Where data were recorded as "Trace amount", zero (0) is used. The SOI Chlor and PCB columns below reflect these adjustments. The units for both are milligrams per kilogram (mg/kg).

Org	Site	WBID	Site Name	Date	Species	County	Type	# in sample	SOI Chlor	PCB
MDC	701/92.2	701	Missouri R. @ Boonville	1976	CAT	COOPER		6		0.81
USEPA	701/39.5	701	Missouri R. @ Jefferson City	1976	MIXED	COLE				0.462
USEPA	701/39.5	701	Missouri R. @ Jefferson City	1976	RED	COLE		1		0.161
USEPA	701/39.5	701	Missouri R. @ Jefferson City	1976	FH CAT	COLE		1		0
USEPA	701/39.5	701	Missouri R. @ Jefferson City	1976	G EYE	COLE		1		0.448
USEPA	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1976	CARP	BUCHANAN		1		0.12
USEPA	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1976	G EYE	BUCHANAN		4		0.281
USEPA	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1976	S GAR	BUCHANAN		1		0.086
USEPA	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1976	CARPSU	BUCHANAN		3		0.166
USEPA	u	356	MO R. KC	1976	CARP			1		0.344
USEPA	u	356	MO R. KC	1976	G SHAD			3		0.751
USEPA	u	356	MO R. KC	1976	BUF			2		0.121
USEPA	u	356	MO R. KC	1976	B CRA			1		0
USGS	1604/97.9	1604	Missouri R. @ Hermann	1979	SM BUF	GASCONADE	W	1		0.9
USGS	1604/97.9	1604	Missouri R. @ Hermann	1979	CARPSU	GASCONADE	W	1		2.2
USGS	1604/97.9	1604	Missouri R. @ Hermann	1979	CARPSU	GASCONADE	W	1		1.7
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1980	B BUF	GASCONADE	W	5		0
EPA/MDNR	226/80.5	226	Missouri R.@ St. Joseph, Mo.	1980	CARP	BUCHANAN	W	5		0
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1981	CARP	GASCONADE	W	5		0

USEPA	226/30.1	226	Missouri R. @ Leavenworth, KS	1981	CARP	PLATTE	W	5		0
USEPA	356/77.4	356	Missouri R. @ Lexington	1981	CARP	LAFAYETTE	W	5		0
USEPA	356/77.4	356	Missouri R. @ Lexington	1981	CARP	LAFAYETTE	W	3		0
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1981	CARP	BUCHANAN	W	5		0
EPA/MDNR	u	356	MO R. KC	1981	CARP		W	5		0
USEPA	u	356	MO R. KC	1981	CARP		W	5		0
USEPA	u	356	MO R. KC	1981	CARP		W	6		22.3
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1982	B BUF	GASCONADE	W	5		0
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1982	CARP	BUCHANAN	W	5		0
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1983	CARP	GASCONADE	W	3		0.24
USEPA	226/30.1	226	Missouri R. @ Leavenworth, KS	1983		PLATTE	W			0
USEPA	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1983		BUCHANAN	W			0
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1983	CARP	BUCHANAN	W	5		0
EPA/MDNR	u	356	MO R. KC	1983	CARP		W	6		0
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1984	CARP	GASCONADE	W	1		0.054
EPA/MDNR	356/77.4	356	Missouri R. @ Lexington	1984	CARP	LAFAYETTE	W	5		0
EPA/MDNR	701/80.7	701	Missouri R. nr. Columbia	1984	CH CAT	BOONE	F	20		0.077
EPA/MDNR	701/80.7	701	Missouri R. nr. Columbia	1984	CARPSU	BOONE	F	20		0.254
EPA/MDNR	701/80.7	701	Missouri R. nr. Columbia	1984	FH CAT	BOONE	F	20		0.095
EPA/MDNR	701/80.7	701	Missouri R. nr. Columbia	1984	SHSTUR	BOONE	F	20		2.52
EPA/MDNR	701/80.7	701	Missouri R. nr. Columbia	1984	CARP	BOONE	F	14		0.058
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1984	CARP	BUCHANAN	W	7		0
EPA/MDNR	u	356	MO R. KC	1984	CARP		W	5		2.11
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1985	CARP	GASCONADE	W	3		0.159
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1985	CARP	GASCONADE	W	3		0.285
EPA/MDNR	356/77.4	356	Missouri R. @ Lexington	1985	CARP	LAFAYETTE	W	5		0.53
EPA/MDNR	356/77.4	356	Missouri R. @ Lexington	1985	CARP	LAFAYETTE	W	5		0
EPA/MDNR	u	356	MO R. KC	1985	CARP		W	4		5.11
EPA/MDNR	u	356	MO R. KC	1985	CARP		W	3		7.49
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1986	CARP	GASCONADE	W	6		0.075
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	CH CAT	BOONE	F			0.075
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	BUF	BOONE	F			0.075
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	E			1.807
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	CARP	BOONE	F			0.075
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	F			0.551
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	E			1.039
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	E			1.512
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	E			1.131
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	E			2.363
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	W BASS	BOONE	F			0.075
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	F			1.265
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	F			0.493
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	CARPSU	BOONE	F			0.356
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	DRUM	BOONE	F			0.123
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	F			0.578
MDC	701/80.7	701	Missouri R. nr. Columbia	1986	SHSTUR	BOONE	F			0.316
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1986	CARP	BUCHANAN	W	5		0.13
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1986	CARP	BUCHANAN	W	5		0.13
EPA/MDNR	u	356	MO R. KC	1986	CARP		W	5		1.225
EPA/MDNR	u	356	MO R. KC	1986	CARP		W	5		2.165
MDC	u	356	MO R. KC	1986	CARP		F	5		0
MDC	u	356	MO R. KC	1986	CH CAT		F	5		0
MDC	701/92.2	701	Missouri R. @ Boonville	1987	FH CAT	COOPER	F	1		0.274
MDC	701/92.2	701	Missouri R. @ Boonville	1987	FH CAT	COOPER	F	5		0.09
MDC	701/92.2	701	Missouri R. @ Boonville	1987	CH CAT	COOPER	F	5		0.205
R	701/92.2	701	Missouri R. @ Boonville	1987	CH CAT	COOPER	F	5		0.092
MDC	701/92.2	701	Missouri R. @ Boonville	1987	CH CAT	COOPER	F	5		0.071
MDC	701/92.2	701	Missouri R. @ Boonville	1987	CH CAT	COOPER	F	1		0.245

MDC	701/92.2	701	Missouri R. @ Boonville	1987	CARP	COOPER	F	5		0.07
MDC	701/92.2	701	Missouri R. @ Boonville	1987	CARP	COOPER	F	5		0.093
MDC	701/92.2	701	Missouri R. @ Boonville	1987	CARP	COOPER	F	1		0.09
MDC	701/92.2	701	Missouri R. @ Boonville	1987	CARPSU	COOPER	F	5		0.068
MDC	701/92.2	701	Missouri R. @ Boonville	1987	SHSTUR	COOPER	F	6		0.303
MDC	701/92.2	701	Missouri R. @ Boonville	1987	DRUM	COOPER	F	5		0.019
MDC	1604/43.9	1604	Missouri R. @ Chesterfield	1987	BM BUF	ST LOUIS	F	5		0.025
MDC	1604/43.9	1604	Missouri R. @ Chesterfield	1987	FH CAT	ST LOUIS	F	3		0.025
MDC	1604/43.9	1604	Missouri R. @ Chesterfield	1987	CARP	ST LOUIS	F	5		0.025
MDC	1604/43.9	1604	Missouri R. @ Chesterfield	1987	BL CAT	ST LOUIS	F	3		0.121
MDC	1604/43.9	1604	Missouri R. @ Chesterfield	1987	CH CAT	ST LOUIS	F	3		0.081
MDC	1604/43.9	1604	Missouri R. @ Chesterfield	1987	CARP	ST LOUIS	F	5		0.025
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1987	CARP	GASCONADE	W	2		0.122
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	FH CAT	PLATTE	F	5		0.025
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CARP	PLATTE	F	1		0.025
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CARP	PLATTE	F	4		0.036
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CH CAT	PLATTE	F	3		0.121
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	FH CAT	PLATTE	F	4		0.121
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CARP	PLATTE	F	5		0.025
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CARP	PLATTE	F	5		0.025
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CARP	PLATTE	F	5		0.025
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	CH CAT	PLATTE	F	5		0.025
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1987	FH CAT	PLATTE	F	5		0.053
MDC	356/77.4	356	Missouri R. @ Lexington	1987	CH CAT	LAFAYETTE	F	5		0.025
MDC	356/77.4	356	Missouri R. @ Lexington	1987	SM BUF	LAFAYETTE	F	1		0.025
MDC	356/77.4	356	Missouri R. @ Lexington	1987	FH CAT	LAFAYETTE	F	5		0.055
MDC	356/77.4	356	Missouri R. @ Lexington	1987	CARP	LAFAYETTE	F	5		0.139
USEPA	356/124.2	356	Missouri R. ab. Hwy. 269	1987	CARP	JACKSON	W	3		0.54
USEPA	356/124.2	356	Missouri R. ab. Hwy. 269	1987	CARP	JACKSON	W	3		0.64
USEPA	356/122.2	356	Missouri R. ab. I-435	1987	CARP	JACKSON	W	3		0.702
USEPA	356/122.2	356	Missouri R. ab. I-435	1987	CARP	JACKSON	W	3		0.425
USEPA	356/119.2	356	Missouri R. bl. Blue R.	1987	CARP	CLAY	W	3		3.22
USEPA	356/119.2	356	Missouri R. bl. Blue R.	1987	CARP	CLAY	W	3		1.26
USEPA	226/6.7	226	Missouri R. bl. I-635	1987	CARP	PLATTE	W	3		0.63
USEPA	226/6.7	226	Missouri R. bl. I-635	1987	CARP	PLATTE	W	3		0.63
USEPA	356/127.2	356	Missouri R. bl. US 169	1987	CARP	JACKSON	W	4		0.673
USEPA	356/127.2	356	Missouri R. bl. US 169	1987	CARP	JACKSON	W	5		0.395
USEPA	356/112.7	356	Missouri R. nr. Shoal Cr.	1987	CARP	CLAY	W	3		0.225
USEPA	356/112.7	356	Missouri R. nr. Shoal Cr.	1987	CARP	CLAY	W	3		0.215
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1987	CARP	BUCHANAN	W	4		0.18
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1987	CARP	BUCHANAN	W	4		0.279
EPA/MDNR	u	356	MO R. KC	1987	CARP		W	3		3
MDC	u	356	MO R. KC	1987	DRUM		F	5		0.025
MDC	u	356	MO R. KC	1987	FH CAT		F	3		0.025
EPA/MDNR	u	356	MO R. KC	1987	CARP		W	3		1.335
MDC	u	356	MO R. KC	1987	CH CAT		F	4		0.025
MDC	u	356	MO R. KC	1987	CH CAT		F	4		0.092
MDC	u	356	MO R. KC	1987	SHSTUR		F	1		0.17
MDC	u	356	MO R. KC	1987	BM BUF		F	5		0.025
MDC	u	356	MO R. KC	1987	SM BUF		F	5		0.025
MDC	u	356	MO R. KC	1987	CARPSU		F	5		0.092
MDC	u	356	MO R. KC	1987	CARP		F	5		0.053
MDC	u	356	MO R. KC	1987	CARP		F	5		0.095
MDC	u	356	MO R. KC	1987	CARP		F	5		0.079
MDC	u	356	MO R. KC	1987	CH CAT		F	3		0.025
MDC	u	356	MO R. KC	1987	FH CAT		F	4		0.025
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1988	CH CAT	GASCONADE	W	4		0.31
USGS	226/30.1	226	Missouri R. @ Leavenworth, KS	1988	CARP	PLATTE	W	5		0.03

USGS	226/30.1	226	Missouri R. @ Leavenworth, KS	1988	G EYE	PLATTE	W	5		0.72
USGS	226/30.1	226	Missouri R. @ Leavenworth, KS	1988	G SHAD	PLATTE	W	5		0.03
USGS	226/30.1	226	Missouri R. @ Leavenworth, KS	1988	SHSTUR	PLATTE	W	5		0.7
USGS	226/30.1	226	Missouri R. @ Leavenworth, KS	1988	CH CAT	PLATTE	W	3		0.3
NDEQ	226/NE		Missouri R. @ Rulo, NE	1988	CARP		F	5	0.049	0
NDEQ	226/NE		Missouri R. @ Rulo, NE	1988	CH CAT		F	3	0.052	0.081
NDEQ	226/NE		Missouri R. @ Rulo, NE	1988	CH CAT		F	3	0.013	0.43
NDEQ	226/NE		Missouri R. @ Rulo, NE	1988	CH CAT			3	0.03	0
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1988	CARP	CLAY	W	4		0.088
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1988	CARP	BUCHANAN	W	5		0.155
USGS	u	356	MO R. KC	1988	CARP		W	5		0.55
USGS	u	356	MO R. KC	1988	DRUM		W	5		0.62
USGS	u	356	MO R. KC	1988	CH CAT		W	5		0.33
MDC	701/92.2	701	Missouri R. @ Boonville	1989	CARP	COOPER	F	5		0.165
MDC	701/92.2	701	Missouri R. @ Boonville	1989	CH CAT	COOPER	F	5		0.111
MDC	701/92.2	701	Missouri R. @ Boonville	1989	FH CAT	COOPER	F	3		0.025
MDC	1604/97.9	1604	Missouri R. @ Hermann	1989	CH CAT	GASCONADE	F	5		0.133
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1989	CARP	GASCONADE	W	1		0.231
MDC	1604/97.9	1604	Missouri R. @ Hermann	1989	CARP	GASCONADE	F	3		0.127
MDC	1604/97.9	1604	Missouri R. @ Hermann	1989	CARP	GASCONADE	F	2		0.131
MDC	701/39.5	701	Missouri R. @ Jefferson City	1989	CH CAT	COLE	F	5		0.072
MDC	701/39.5	701	Missouri R. @ Jefferson City	1989	CARP	COLE	F	5		0.093
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1989	CH CAT	PLATTE	F	5		0.173
MDC	226/30.1	226	Missouri R. @ Leavenworth, KS	1989	CARP	PLATTE	F	5		0.025
MDC	1604/28.0	1604	Missouri R. @ St. Charles	1989	CARP	ST CHARLES	F	5		0.151
MDC	1604/28.0	1604	Missouri R. @ St. Charles	1989	CH CAT	ST CHARLES	F	3		0.161
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1989	CARP	CLAY		5		1.82
MDC	701/80.7	701	Missouri R. nr. Columbia	1989	CH CAT	BOONE	F	5		0.025
MDC	701/80.7	701	Missouri R. nr. Columbia	1989	SHSTUR	BOONE	F	5		0.078
MDC	701/80.7	701	Missouri R. nr. Columbia	1989	CARP	BOONE	F	2		0.087
MDC	701/80.7	701	Missouri R. nr. Columbia	1989	CARP	BOONE	F	3		0.025
MDC	701/80.7	701	Missouri R. nr. Columbia	1989	CH CAT	BOONE	F	2		0.025
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1989	CH CAT	CLAY		5		0.082
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1989	CARP	CLAY		5		0.056
EPA/MDNR	226/80.5	226	Missouri R.@ St. Joseph, Mo.	1989	CARP	BUCHANAN	W	4		0.167
MDC	701/92.2	701	Missouri R. @ Boonville	1990	CARP	COOPER	F	5		0.1
MDC	701/92.2	701	Missouri R. @ Boonville	1990	CH CAT	COOPER	F	5		0.025
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1990	CARP	GASCONADE	W	3		0.367
MDC	1604/97.9	1604	Missouri R. @ Hermann	1990	SHSTUR	GASCONADE	F	5		0.285
MDC	1604/97.9	1604	Missouri R. @ Hermann	1990	CARP	GASCONADE	F	5		0.106
MDC	1604/97.9	1604	Missouri R. @ Hermann	1990	PADDLE	GASCONADE	F	1		0.025
MDC	1604/97.9	1604	Missouri R. @ Hermann	1990	CH CAT	GASCONADE	F	5		0.192
MDC	1604/97.9	1604	Missouri R. @ Hermann	1990	PADDLE	GASCONADE	F	1		0.025
MDC	701/39.5	701	Missouri R. @ Jefferson City	1990	CARP	COLE	F	5		0.025
MDC	701/39.5	701	Missouri R. @ Jefferson City	1990	CH CAT	COLE	F	5		0.084
MDC	226/6.7	226	Missouri R. bl. I-635	1990	FH CAT	PLATTE	F	5		0.025
MDC	226/6.7	226	Missouri R. bl. I-635	1990	CARP	PLATTE	F	5		0.025
MDC	356/36.4	356	Missouri R. nr. Malta Bend	1990	CARP	SALINE		5		0.091
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1990	CARP	CLAY	F	5		0.124
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1990	CH CAT	CLAY	F	5		0.079
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1990	CARP	BUCHANAN	W	5		0.355
MDC	701/121.9	701	Missouri R. @ Glasgow	1991	CH CAT	HOWARD				0
NDEQ	226/NE		Missouri R. @ Rulo, NE	1991	CH CAT		F	5	0.035	0
NDEQ	226/NE		Missouri R. @ Rulo, NE	1992	CH CAT		F	4		
NDEQ	226/NE		Missouri R. @ Rulo, NE	1992	CH CAT		F	4		
NDEQ	226/NE		Missouri R. @ Rulo, NE	1992	CH CAT		F	4		
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1992	CARP	CLAY		1		
EPA/MDNR	1604/97.9	1604	Missouri R. @ Hermann	1993	CARP	GASCONADE	W	2		0.05

EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1993	CARP	BUCHANAN	W	3		0.23
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1994	CARP	CLAY	F	18		0.025
MDC	356/112.7	356	Missouri R. nr. Shoal Cr.	1994	CARP	CLAY	F	18		0.161
USGS-BEST	1604/97.9	1604	Missouri R. @ Hermann	1995	BASS	GASCONADE	W	17	0.05	0.05
USGS-BEST	1604/97.9	1604	Missouri R. @ Hermann	1995	CARP	GASCONADE	W	15	0.09	0.3
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1995	CARP	CLAY	W	5		0.443
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1995	CARP	BUCHANAN	W	5		0.079
NDEQ	226/NE		Missouri R. @ Rulo, NE	1996	CH CAT		F	5	0.03	0.093
MDC	1604/28.0	1604	Missouri R. @ St. Charles	1996	SHSTUR	ST CHARLES	F	13	0.113	0.025
MDC	1604/28.0	1604	Missouri R. @ St. Charles	1996	SHSTUR	ST CHARLES	E		0.105	0.025
MDC	1604/28.0	1604	Missouri R. @ St. Charles	1996	CARP	ST CHARLES	F	23	0.066	0.112
MDC	1604/28.0	1604	Missouri R. @ St. Charles	1996	CH CAT	ST CHARLES	F	24	0.054	0.065
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	CARP	BOONE	F	14	0.054	0.079
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	BUF	BOONE	F	15	0.073	0.131
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	SHSTUR	BOONE	F	25	0.018	0.23
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	CARP	BOONE	F	14	0.059	0.074
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	CARP	BOONE	F	17	0.053	0.084
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	BUF	BOONE	F	10	0.066	0.025
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	SHSTUR	BOONE	E	5	0.096	0.354
MDC	701/80.7	701	Missouri R. nr. Columbia	1996	CH CAT	BOONE	F	25	0.073	0.059
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	SHSTUR	BUCHANAN	F	7	0.039	0.183
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	CH CAT	BUCHANAN	F	25	0.019	0.025
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	CARP	BUCHANAN	F	17	0.017	0.025
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	SHSTUR	BUCHANAN	E		0.188	0.586
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	CARP	BUCHANAN	F	28	0.032	0.025
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	BUF	BUCHANAN	F	6	0.077	0.102
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	BUF	BUCHANAN	F	11	0.054	0.025
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	SHSTUR	BUCHANAN	F	13	0.038	0.099
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1996	SHSTUR	BUCHANAN	E		0.299	0.698
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1997	CARP	CLAY	W	4		1.56
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1997	CARP	CLAY	W	3		1.26
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1997	CARP	BUCHANAN	F	25	0.04	0.025
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1997	CH CAT	BUCHANAN	F	15	0.024	0.025
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1997	CARP	BUCHANAN	W	4		0.092
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	1998	CARP	ST LOUIS	F	25	0.032	0.083
MDC	701/80.7	701	Missouri R. nr. Columbia	1998	FH CAT	BOONE		15	0.005	0.02
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1999	CARP	CLAY	W	5		0.126
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	1999	CARP	CLAY	W	5		0.22
MDC	701/80.7	701	Missouri R. nr. Columbia	1999	CARP	BOONE	F	25	0.042	0.025
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	1999	CARP	BUCHANAN	W	5		0.187
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2000	FH CAT	ST CHARLES	F	16	0.016	0.053
MDC	226/93.4	226	Missouri R. bl. Nodaway R.	2000	CH CAT	ANDREW		15	0.009	0.009
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	2000	CARP	BUCHANAN	F	10	0.092	0.029
MDC	226/80.5	226	Missouri R. @ St. Joseph, Mo.	2000	CARP	BUCHANAN	F	15	0.04	0.022
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	2001	CARP	CLAY	W	5		0.802
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	2001	CARP	BUCHANAN	W	5		0.154
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	2001	CARP	BUCHANAN	W	5		0.262
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2002	CARP	ST CHARLES	F	15	0.04	0.052
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2002	FH CAT	ST CHARLES	F	17	0.028	0.077
MDC	701/80.7	701	Missouri R. nr. Columbia	2002	CARP	BOONE	F	26	0.018	0.028
MDC	356/23.4	356	Missouri R. @ Miami	2004	SHSTUR	SALINE	F	5	0.037	0.229
MDC	356/23.4	356	Missouri R. @ Miami	2004	SHSTUR	SALINE	F	5	0.024	0.278
MDC	356/23.4	356	Missouri R. @ Miami	2004	SHSTUR	SALINE	F	5	0.018	0.165
MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	E	1	0.105	1.14
MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	E	1	0.144	1.52
MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	F	5	0.025	0.393

MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	F	5	0.049	0.346
MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	F	5	0.093	0.807
MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	E	1	0.086	
MDC	701/19.7	701	Missouri R. @ Mokane	2004	SHSTUR	CALLAWAY	E	1	0.056	0.454
MDC	356/87.7	356	Missouri R. @ Napoleon	2004	SHSTUR	LAFAYETTE		15	0.05	0.483
MDC	356/87.7	356	Missouri R. @ Napoleon	2004	SHSTUR	LAFAYETTE		6	0.39	4.01
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW	E	1	0.133	0.889
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW		5	0.031	0.22
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW		5	0.022	0.23
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW	E	1	0.193	0.532
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW	E	1	0.077	0.758
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW	F	5	0.038	0.422
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW	E	1	0.14	0.867
MDC	226/99.6	226	Missouri R. @ Nodaway Island Access	2004	SHSTUR	ANDREW	E	1	0.103	0.726
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2004	SHSTUR	ST CHARLES		5	0.036	0.184
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2004	SHSTUR	ST CHARLES	E	1	0.114	0.57
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2004	SHSTUR	ST CHARLES	E	1	0.07	1.1
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2004	SHSTUR	ST CHARLES	F	5	0.058	0.431
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2004	SHSTUR	ST CHARLES	F	5	0.058	0.739
MDC	1604/47.5	1604	Missouri R. @ Weldon Spring CA	2004	SHSTUR	ST CHARLES	E	1	0.113	0.766
EPA/MDNR	356/119.2	356	Missouri R. bl. Blue R.	2005	C CARP	JACKSON		5		0.58
EPA/MDNR	226/80.5	226	Missouri R. @ St. Joseph, Mo.	2005	C CARP	BUCHANAN	W	5		0.049

Note: Site = WBID/number of miles from mouth; u = urban; r = rural; # in sample = the number of fish in each “sample”.
Type = what form of the fish is evaluated:
W = the whole fish
F = the fillet of the fish only
E = the fish eggs only